CLAIMS

We claim:

1. A stress profile system, comprising:

at least one contact stress sensor positioned within a wellbore to sense stresses between a casing and a contact surface; and

an analyzer, wherein said analyzer receives stress data from said contact sensor, and wherein the analyzer is capable of determining pressure perturbation.

2. The stress profile system of claim 1, wherein the effect of the pressure perturbation on a contact stress may be determined by the analyzer.

3. The stress profile system of claim 2, wherein the contact stress sensor comprises three or more contact stress sensors disposed about the circumference of the casing.

4. The stress profile system of claim 3, wherein the contact surface is selected from the group consisting of a cement sheath, formation, gravel pack, concentric casing and combinations thereof.

5. The stress profile system of claim 4, wherein the contact surface is the cement sheath.

6. The stress profile system of claim 4, wherein the contact surface is the formation.

7. The stress profile system of claim 4, wherein the contact surface is the gravel pack.

8. The stress profile system of claim 4, wherein the contact surface is the concentric casing.

9. The stress profile system of claim 3, wherein the contact stress sensors comprise fiber optic sensors.

10. The stress profile system of claim 3, wherein the fiber optic sensors comprise piezo electric sensors.

11. The stress profile system of claim 3, wherein the fiber optic sensors comprise acoustic sensors.

12. The stress profile system of claim 3, wherein the fiber optic sensors comprise strain gauge sensors.

13. A method to determine the preferred fracture orientation for optimized hydraulic fracture treatments in a wellbore, comprising:

providing a stress profile system having a contact stress sensor;

locating said contact stress sensor;

measuring contact stress between a casing and a contact surface disposed about the casing;

perforating the casing in a pre-selected geological test zone;

performing a hydraulic fracture treatment within the test zone to induce changes in the contact stress;

measuring changes induced in the contact stress between the casing and the contact surface;

determining formation stress around the wellbore; and

determining a preferred hydraulic fracture orientation.

14. The method of claim 13, wherein the step of determining the formation stress comprises:

measuring a fracturing pressure during the step of performing a hydraulic fracture treatment within the test zone; and

measuring post fracture contact stress at the test zone after performing a hydraulic fracture treatment within the test zone.

15. The method of claim 14, further comprising the steps of:

re-perforating the subterranean formation according to the preferred orientation of the hydraulic fracture; and

performing a hydraulic fracture treatment aligned with the preferred orientation of the hydraulic fracture.

16. The method of claim 15, wherein the post fracture contact stresses is selected from the group consisting of formation stress, fracture closure stress, minimum formation stress, and in-situ stress.

17. The method of claim 16, wherein the post fracture stress is the formation stress.

18. The method of claim 16, wherein the post fracture stress is the fracture closure stress.

19. The method of claim 16, wherein the post fracture stress is the minimum formation stress.

20. The method of claim 16, wherein the post fracture stress is the in-situ stress.

21. The method of claim 16, wherein the step of determining a preferred hydraulic fracture orientation comprises determining the far field stress and a fracture geometry.

22. The method of claim 21, wherein the step of determining a preferred hydraulic fracture orientation comprises calculating a preferred hydraulic fracture orientation according to the following equations:

$$div\sigma = 0 \qquad \text{on body B}$$

$$\varepsilon = \frac{1}{2}\left(\nabla u + \nabla u^T\right)$$

$$\sigma = L[\varepsilon]$$

$$e_i \cdot (\sigma \cdot n) = \hat{\sigma}_i \qquad \text{on } \partial B_{1i}\text{, the surface of B}$$

$$e_i \cdot u(x_\beta) = \hat{u}_i(x_\beta) \qquad \text{on } \partial B_{1i}\text{, } \beta = 1, N_s$$

23. The method of claim 22, wherein the step of calculating the formation stress comprises:

measuring a fracture formation stress during the step of performing a hydraulic fracture treatment within the test zone;

measuring a post fracture formation stress after the step of performing a hydraulic fracture treatment within the test zone.

24. The method of claim 23, wherein the formation stress comprises the initial formation stress, fracture formation stress and post fracture formation stress.

25. The method of claim 24, wherein the step of determining a preferred hydraulic fracture orientation comprises calculating far field stress data, a well departure angle and a fracture plane geometry.

26. The stress profile analyzer of claim 25, wherein the effect of the pressure perturbation on a contact stress may be determined by the data processor.

27. The stress profile analyzer of claim 26, wherein the contact stress sensor array comprises three or more contact stress sensors disposed about the circumference of the casing.

28. The stress profile analyzer of claim 27, wherein the contact surface is selected from the group consisting of a cement sheath, formation, gravel pack, concentric casing and combinations thereof.

29. The stress profile analyzer of claim 28, wherein the contact surface is the cement sheath.

30. The stress profile analyzer of claim 28, wherein the contact surface is the formation.

31. The stress profile analyzer of claim 28, wherein the contact surface is the gravel pack.

32. The stress profile analyzer of claim 28, wherein the contact surface is the concentric casing.

33. The stress profile analyzer of claim 27, wherein the contact stress sensors comprise fiber optic sensors.

34. The stress profile analyzer of claim 27, wherein the fiber optic sensors comprise piezo electric sensors.

35. The stress profile analyzer of claim 27, wherein the fiber optic sensors comprise acoustic sensors.

36. The stress profile analyzer of claim 27, wherein the fiber optic sensors comprise strain gauge sensors

37. The method of claim 27, wherein the step of determining a preferred hydraulic fracture orientation comprises calculating a preferred hydraulic fracture orientation according to the following equations:

$$div\sigma = 0 \qquad \text{on body B}$$

$$\varepsilon = \frac{1}{2}\left(\nabla u + \nabla u^{T}\right)$$

$$\sigma = L[\varepsilon]$$

$$e_i \cdot (\sigma \cdot n) = \hat{\sigma}_i \qquad \text{on } \partial B_{1i}\text{, the surface of B}$$

$$e_i \cdot u(x_\beta) = \hat{u}_i(x_\beta) \qquad \text{on } \partial B_{1i},\ \beta = 1, N_s$$

38. A method to assess the degree of shrinkage of a sealant between a casing and a formation, comprising:

providing a stress profile analyzer having a contact stress sensor array and a data processor;

installing said contact stress sensor array on a wellbore casing;

measuring a contact stress between the casing, sealant and formation while the sealant is curing; and

calculating a shrinkage value based on the change in contact stress over time using a basing analytical elasticity algorithm.

39. The stress profile analyzer of claim 38, wherein the effect of the pressure perturbation on a contact stress may be determined by the data processor.

40. The stress profile analyzer of claim 39, wherein the contact stress sensor array comprises three or more contact stress sensors disposed about the circumference of the casing.

41. The stress profile analyzer of claim 40, wherein the contact surface is selected from the group consisting of a cement sheath, formation, gravel pack, concentric casing and combinations thereof.

42. The stress profile analyzer of claim 41, wherein the contact surface is the cement sheath.

43. The stress profile analyzer of claim 41, wherein the contact surface is the formation.

44. The stress profile analyzer of claim 41, wherein the contact surface is the gravel pack.

45. The stress profile analyzer of claim 41, wherein the contact surface is the concentric casing.

46. The stress profile analyzer of claim 40, wherein the contact stress sensors comprise fiber optic sensors.

47. The stress profile analyzer of claim 40, wherein the fiber optic sensors comprise piezo electric sensors.

48. The stress profile analyzer of claim 40, wherein the fiber optic sensors comprise acoustic sensors.

49. The stress profile analyzer of claim 40, wherein the fiber optic sensors comprise strain gauge sensors

50. A method to assess the quality of a bond between a casing and a sealant, comprising:

providing a stress profile system having a contact stress sensor and a data processor;

installing said contact stress sensor about a wellbore casing;

applying pressure to an inside diameter of the casing;

measuring an induced contact stress between the casing and sealant;

determining when a contact occurs between the casing and the sealant utilizing the induced contact stress measurements; and

calculating a casing deflection to establish contact between the casing and sealant.

51. The stress profile system of claim 50, wherein the effect of the pressure perturbation on a contact stress may be determined by the data processor.

52. The stress profile system of claim 51, wherein the contact stress sensor array comprises three or more contact stress sensors disposed about the circumference of the casing.

53. The stress profile system of claim 52, wherein the contact surface is selected from the group consisting of a cement sheath, formation, gravel pack, concentric casing and combinations thereof.

54. The stress profile system of claim 53, wherein the contact surface is the cement sheath.

55. The stress profile system of claim 53, wherein the contact surface is the formation.

56. The stress profile system of claim 53, wherein the contact surface is the gravel pack.

57. The stress profile system of claim 53, wherein the contact surface is the concentric casing.

58. The stress profile system of claim 52, wherein the contact stress sensors comprise fiber optic sensors.

59. The stress profile system of claim 52, wherein the contact stress sensors comprise piezo electric sensors.

60. The stress profile system of claim 52, wherein the contact stress sensors comprise acoustic sensors.

61. The stress profile system of claim 52, wherein the contact stress sensors comprise strain gauge sensors.